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Roles, trends and challenges of neglected and underutilized species in Ghana. A review of the literature

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CCAFS

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Cover Photo: Two neglected and underutilized species found in Ghana's markets: coco yam leaf and Turkey berry. Credit: The Alliance of Bioversity International and CIAT/R. Vernooy

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1. Neglected and underutilized species in Africa

In Africa, farming communities have conserved neglected and underutilized species (NUS), also known as minor or orphan crops, as part of local food systems for centuries. NUS are important for food and nutrition, as animal feed, for medicinal use; play a role in socio-cultural traditions; and contribute to income generation. NUS also contribute to securing non-food related ecosystem services from agriculture, including climate mitigation, water flow and water quality control. The NUS diversity currently available can be attributed largely to the efforts of famer communities to sustainably use these species and varieties. However, NUS are increasingly under pressure, due to a number of forces. These include: population growth; expansion of land cultivated with staple and cash crops; dwindling pollinator and disperser populations (due to modern agriculture, environmental degradation and pollution); unavailability of seed and other planting material; migration of younger generations to cities; changing eating preferences and habits (from nutrient rich to energy rich foods); and, limited attention to and support for NUS in research, extension, education and policy.[1]

NUS can be grouped based on two characteristics: 1) life cycle −annual, short lived; and perennial, long lived; and 2) consumable, edible parts and purpose of use −fruit vegetables, small trees/shrubs with edible fruits/nuts/seeds, leafy vegetables, cereal grains, grain legumes, medicinal annual crops, edible roots and tubers, industrial annual crops. A recent compilation of NUS identified 121 NUS in Africa of which about 40% are trees/shrubs (FARA-GFAR-CCADP X4 Programme 2021). The same document reports that 46% of all NUS cultivated in Africa have Africa as their center of origin. Within the African continent, the distribution of NUS by West, Central, East and Southern Africa ranges from 22-26%. North Africa has about 6% of all NUS identified. NUS in general are affordable (many of them can be harvested from the wild), ready available, acceptable (part of local diets, although eating habits are changing) and nutritious, i.e. rich in micro-nutrients. Most of the NUS are easily edible, but some are hard to process, some difficult to digest, and some not easy to conserve for a longer time.

The very comprehensive review study of African leafy vegetables by van Zonneveld et al. (2020) identified (prioritized) 126 traditional annual and perennial African vegetables for their nutrition and food potential. Of these, the most referenced annual vegetables are vegetable amaranth (*Amaranthus cruentus*); African eggplant (*Solanum aethiopicum*); roselle (*Hibiscus sabdariffa*); jute mallow (*Corchorus olitorius*); Ethiopian mustard (*Brassica carinata*); spider plant (*Cleome gynandra*); the two most referenced perennials are baobab (*Adansonia digitata*) and moringa (*Moringa oleifera*). The study identified high species richness in a number of sub-regions, including West Tropical Africa (Benin, Ghana and Togo). However, the authors warned that there is an urgent need to increase the conservation efforts in West Tropical Africa, a region where vegetables genetic resources are poorly represented in *ex situ* collections. Germplasm collection missions are urgently needed to safeguard genetic resources and related farmer knowledge.

[1] An exception is the African Orphan Crops Consortium (AOCC), which is developing genomic resources for 101 African orphan crops. The chosen crops were identified in a participatory manner as being important for supporting consumers' diets and farmers' incomes in Africa. See: http://africanorphancrops.org/

Across the continent, accessions have been collected, characterized, regenerated and stored for short and long durations; information on each accession can be found online. However, many landraces and crop wild relatives still need to be added to the genebank collections. Although some accessions have been used for plant breeding (with good results), more could be done to evaluate NUS under changing conditions and assess their potential for climate change adaptation. Conservation, crop management, processing and packaging, and marketing (value chain development) of NUS are all areas that require greater attention (Dinnsa et al. 2013; Mwadzingeni et al. 2021). The recently published African Manifesto for Forgotten Foods (FARA-GFAR-CCADP X4 Programme 2021), part of a global initiative (manifesto) about forgotten foods, calls for immediate action in these and other areas.

2. NUS in Ghana: trends and challenges

For rural communities in Ghana, NUS are important for nutrition, food security and income generation. However, little is known about their diversity and potential (Nyadanu et al. 2016). Unfortunately, very little has been published about NUS in Ghana. A combined search on the Web of Science and CABI Direct for the period 2010-2021 resulted in about 20 articles. The following sections are based on information distilled from this set plus a few additional references.[2]

2.1 Status of NUS in the country

Two studies (Nyadanu et al. 2016, Baa-Poku and Asante 2020) allow obtaining an overview of how many and which NUS are mostly cultivated in the country. The highest number listed for Ghana is 72 (Nyadanu et al. 2016), which is about 60% of the number [126] for all of Africa (reported by van Zonneveld et al. 2020, referred to above). However, these studies observe that NUS cultivation is under pressure due to socio-economic changes, modernization of agriculture (mono-cropping, mechanization and use of chemical inputs), agrarian conflicts (e.g. livestock infringement on cropland) changing eating habits and policies that are not favoring NUS production and consumption. In addition, NUS are reported to suffer from genetic erosion.

The 72 species identified by Nyadanu et al. (2016), based on a country survey across all agro-ecological regions, include 21 indigenous vegetables, 8 root and tuber crops, 7 cereals, 12 legumes and 24 edible wild fruit trees. Within each category, the market value ranged from low to high. The species that have high market value are usually cultivated on-farm, popular among consumers, and eaten in many local dishes. The species with low market value are usually harvested in the wild, and have low demand. NUS often do not travel far, but are utilized by ethnic groups living in certain territories. Among the indigenous vegetables that were of high market value and regularly bought by consumers, were: *Solanum aethiopicum* (Ethiopian eggplant or bitter tomato), *Solanum nigrum* (black nightshade),

[2] This review is part of the activity "The potential of agrobiodiversity for improving diets and nutrition in Ghana," which forms part of the umbrella agreement between the Ministry of Agriculture, Nature and Food Quality of the Dutch government and Bioversity International (now the Alliance of Bioversity International and CIAT) to work together on resilient seed systems for climate change adaptation and sustainable livelihoods in Africa.

Curcurbita maxima (winter squash), *Cucumeropsis edulis* (a melon species, known in some parts of West Africa as "egusi"), *Corchorus olitorius* (jute mallow), *Solanum macrocarpon* (African garden egg or eggplant), *Talinum triangulare* (waterleaf) and *Amaranthus cruentus* (red Amaranthus). Among the popular roots and tubers were *Colocasia esculenta* (taro), *Xanthosoma sagittifolium* (arrowleaf elephant['s] ear), *Ipomoea batatas* (sweet potato), *Dioscorea cayenensis* (yellow [Guinea] yam (Photo 1)). Among the cereals were *Sorghum bicolor* (sorghum) and *Pennisetum glaucum* (pearl millet); among the legumes, *Vigna subterranea* (Bambara groundnut), and among the fruit tree species, *Dialium guineense* (velvet tamarind), *Irvingea gabonensis* (African or wild or bush mango), *Adansonia digitate* (African baobab), and *Parkia biglobosa* (African locust bean). This is a list of 20 popular species.

Photo 1

Yellow yam.
Credit: The Alliance of Bioversity International and CIAT/R. Vernooy

These authors identified several constraints for the on-farm conservation of NUS species across the regions, depending on the farming systems practiced. The coastal and forest zones use slash and burn as a cultural practice in land preparation. Farmers in the savanna and transitional zones rear cattle and use bullocks in farming; grazing becomes as a constraint for conservation. The use of weedicides is common across the country, killing NUS indiscriminately and eliminating their soil seed bank (due to the use of systemic weedicides). Another common constraint is the lack of knowledge about effective conservation and storage practices. The latter hinders the design of effective on-farm conservation strategies, for example, by community seed banks or similar organizations at community level [research on community seed banks around the globe could not identify any community seed bank established in Ghana in 2015; Vernooy et al. 2015]. No recent inventory studies could be found, which makes it difficult to know if there is a decline in total number and/or distribution of NUS found in the country.

2.2 NUS crop species in the Upper Afram and Upper Dayi River Basins in Ghana

Recent research by Baa-Poku and Asante (2020) identified the following NUS being cultivated in some parts of the country. Crops include:

1. Cereals: Maize sp. (*Zea mays*) -dwarf, *Baatampa, Abrohama* (long cob with lots of smaller grains), *Dobidi* (white), *Daduanan* (yellow), *Laposta*, *Mamaba* (white), *Okomasa* (white), *Abelehi* (white); *Debo* or millet (*Pennisetum glaucum*); sorghum (*Sorghum bicolor*); *Ekpe* (in Kokomba language) or fonio; *Mokoko* or indigenous brown rice (*Oryza glaberrima*); rice sp.- *Twomavor, Mawulukpu Akuablue, Kable, Khaki, Akpese, Mawutse, Tomayobi*
2. Legumes: Bambara beans (*Vigna subterranea*), *Agushi* (*Citrullus colocynthis*), *Werewere* (*Citrullus vulgaris*); Bean varieties: *Atidua* (red bean – *Vigna* sp.), *Apatram* (white; *Phaseolus vulgaris*), *Akye*, *Aduakuma* (coloured; *Phaseolus sp*.), *Aduapia* (Phaseolus sp.), *Adua daagati* (*Vigna sp*.), Pangabu (*Vigna sp*.), Forehead (*Vigna sp., whitish*), Osei (*Vigna sp., spotted*); red groundnut (*Arachis hypogaea*); Bambara bean (*Vigna subterranea*), *Apatram* (*Phaseolus sp*.), *Akani*, *Kakpe*, *Agushi* (*Citrullus colocynthis*)
3. Vegetables: *Efre* (pumpkin, *Cucurbita maxima*), *Misewa* (pepper, *Capsicum anmum*), *Monsurowa* (a type of garden eggs, *Solanum sp*.), *Kwahu nsusua* (turkey berry, *Solanum torvum*), Cucumber (*Cucumis sativus*), Shallot (*Alium spp*.), Misewa (pepper, *Capsicum anmum*), Soro wisa (African Black pepper), Bitter leaves (*Vernonia amygdalina*), *Akpamkpele* (small garden eggs, *Solanum spp*.)
4. Roots and tubers: *Nkanfoɔ* (*Dioscorea dumetorum*), Cocoyam (*Xanthosoma spp.*), Taro (*Colocasia esculenta*), Sweet potato (*Ipomoea batatas*); Yam species: varieties: *Bayere Kwankwesi*, *Asobayere* (hard with sweet taste), *Ahabayere*, *Apoka* (big roundish), *Anomesu*, *Nsuabayere*, *Densi* (*Esum ne Hyen*), *Nananto* (good taste and flavour), *Akaba*, *Krokropa Nkanfo* (*Dioscorea dumetorom*); Sweet potato (*Ipomoea batatas*); Taro (*Colocasia esculenta*); Yam varieties: *Nakani, Oboaduanan, Befosi, Seklorsi, Aerial yam, Kookoasi bayere, Snake water yam*

The authors observed that some varieties of leguminous crops, such as Bambara bean (*Vigna subterranea*), *Agushi* (*Citrullus colocynthis*) and *Phaseolus sp*., which contain important nutrients, are under-cultivated and marginalized. They also expressed concern about the genetic erosion of over

twenty yam species recorded during the study given that yam plays an important role in culture (festivals) and diets (boiled, roasted or fried), e.g. for making *ampesi* (boiled starchy staple served with stew or sauce), *ɔtɔ* (mashed yam), *fufu* (pounded yam), yam balls, porridge and fried yam chips. The authors warned that erosion of yam varieties could result in cultural identity loss of some tribal groups.

3. Some NUS examples

African locust bean (*Parkia biglobosa*) is a non-timber leguminous tree species in Sahelian zones of Africa. Despite its multipurpose uses by local inhabitants, not much is known about its nutritional importance and ethnobotany in Ghana. Farmers use the species for food, medicine and firewood. Men are involved in the collection of the fruits and women process the seed into “dawadawa”, a protein rich condiment. The leaf, bark, root and fruit of the plant are used to treat various medical problems including fever, diarrhea, stomach problems, boils and burns. Bad odor, limited market access, lack of elite genotypes, bush fires and tedious labor operations were the main constraints of African locust bean production (Nyadanu et al. 2016).

African yam bean (*Sphenostylis stenocarpa*) is a little known (and studied) NUS (alike to cow pea/ *Vigna unguiculata*), with edible seed and tuber, but reported to be of high nutritious value and with good market potential, grown in the middle belt of the Upper Volta Region (Amoatey et al. 2000).

Bambara groundnut (*Vigna subterranea*) is a productive, drought- and heat-tolerant crop, with high nutritional value. In recent years, Adu-Dapaah et al. (2016) reported that work has been done on germplasm collection and evaluation; genetic improvement through mutation breeding; biotechnological approaches to shorten the generation cycle; performance of the first ever successfully crossed Bambara groundnuts; evaluation for heat and drought tolerance; evaluation of other agronomic and physiological traits; and determination of physico-chemical composition, and key functional properties to harness potential in food product development. Among the landraces evaluated, the landrace 'Burkina' exhibited drought and heat tolerance, with pod yield of 1.2 t ha-1 under heat treatment. 'Zebra Coloured' was the earliest maturing genotype. Early-maturing landraces were observed to be less sensitive to photoperiod.

A study on **cowpea** (*Vigna uncuiculata*) cultivation was conducted in Kumbosco, Zuarungu and Yarigabisi in the Bolgatanga Municipality of the Upper East Region of Ghana. The findings from the study showed that farmers in these three communities cultivated cowpea intercropped with millet; not as a main crop. In the study areas, cowpea is mostly a male crop. Most of the farmers used the local white variety (77%) for cultivation as compared to the improved varieties Boufor, Asontem and Red Nkwanta. Smaller families of 1-5 persons rely considerably on the crop for sale and consumption with fields up to one acre (Akpalu et al. 2014).

Ethiopian garden egg or eggplant (*Solanum aethiopicum*, *family solanaceae*), unlike many other underutilized species, is supported by some recently generated general scientific knowledge on its nutritional content and some of its medicinal properties. Efforts to improve the crop through plant breeding have been very limited in the country. Germplasm collected shows a considerable amount of

diversity, but little research has been done to evaluate factors that determine and affect this diversity. The low public value of the crop has not encouraged a larger allocation of research resources and there is no strategy in place to conserve the diversity of garden egg (Hornal et al. 2007).

Photo 2

Frafra potato.
Credit: The Alliance of Bioversity International and CIAT/R. Vernooy

Frafra potato (*Solenostemon rotundifolius*) is an underutilized crop with enormous potential as food security crop (Photo 2). Sensory attributes of bread and *koose* (a traditional Ghanaian pastry) produced from 10 varieties of Frafra potato flour as composite flour and nutritional values were analyzed. Bread and *koose* produced from partial substitution of Frafra potato flour were comparable to wholly wheat flour, especially 20% substitution with variety UW022 for bread and 30% substitution with variety UE021 for *koose*. Using a 9- point Hedonic scale, overall acceptability level was 7.8 for variety UW022 for bread compared to 7.9 for wheat flour, similar to *koose*. Variety UW022 bread was carbohydrate dense (72.58 g/100 g) whereas variety UE023 bread was richer in ash, fat, protein, crude fiber and energy. Variety UE023 koose at 20% was highest in protein content (20.75 g/100 g), but lower in carbohydrates (47.3 g/100 g) (Tortoe et al. 2020).

Jute mallow (*Corchorus olitorius*, family malvaceae), a leafy vegetable, is rich in proteins, vitamins and essential amino acids. Ethno-botanical knowledge on the crop in Ghana is incomplete and little is known about variation and diversity of local accessions. An ethnobotanical survey among 4000 farmers in twenty districts resulted in the collection and characterization of four clusters of accessions by 12 quantitative and six qualitative traits. Some local cultivars which were known in the past are no longer cultivated, pointing to genetic erosion of jute mallow in the country. Jute mallow was used as a food and to treat fever, waist pain, stomach problems and loss of appetite. Hierarchical cluster analysis grouped the accessions into four distinct clusters and individuals from the same geographical origin were separately classified. Accessions Cagric 26, Cagric 28, Cagric 41, Cagric 08 and Cagric 01 recorded high yields and could be used as parents for breeding of improved cultivars (Nyadanu et al. 2017).

Four underutilized **wild fruits**, *Gardenia erubescens*, marula (*Sclerocarya birrea*), jackalberry (*Diospyros mespiliformis*), and Egyotian balsam (*Balanites aegyptiaca*), of dietary interest in Ghana were analyzed to have high enough contents to contribute to the nutrient requirements of humans, with iron (0.34-1.46 mg/100 g), zinc (0.81-2.97 mg/100 g), vitamin A (0.84-2.03 mg/100 g), and β-carotene (64.84-176.89 mg/100 g) contents worth special mention. The antinutrient content ranged between 0.06-1.82 mg/g. These four fruits, although containing some levels of antinutrients, are nutrient-dense, and could contribute to fight malnutrition (Achaglinkame et al. 2019).

3.1 African leafy vegetables in Accra Markets

According to recent studies (2016 and 2018) about NUS consumption, NUS and leafy vegetables in particular are still important parts of eating habits, at least in Accra, with most of the supplies coming from rural Ghana, complemented with import from Togo. However, it was remarked that NUS can only be purchased at fresh markets and not in supermarkets (such as is the case in Kenya, for example)[3]. It is not known what impact COVID-19 has had on market supplies and, as a result, on consumption.

[3] This is no longer the case: a small number of NUS, in particular roots and tubers, are on sale in Accra's larger supermarket (personal observations (November 2021).

Photo 3

Amaranth plant.
Credit: The Alliance of Bioversity International and CIAT/R. Vernooy

Asase et al. (2018) identified, in an ethnobotanical study done in 2017 at four popular, large Accra markets (Madina, Agbobloshie, Malata and Kaneshie) the sale of six species of African leafy vegetables belonging to five families. With the exception of waterleaf (*Talinum triangulare* (Jacq.) Willd.), which was identified only at the Malata market, all the other species of plants were available everywhere. The most frequently identified were amaranth (*Amaranthus cruentus L*. (Photo 3)) and Jew's mallow (*Corchorus olitorius L*.); but the lists of each market differed. In Agbobloshie and Madina, Jew's mallow was most commonly identified, while arrowleaf elephant ear (*Xanthosoma sagittifolium (L.)*) *Schott* in Kaneshie, and amaranth in the Malata market. The economic value of amaranth is high among the African leafy vegetables.

The authors mention that, apart from their nutritional values, the plants identified were also reported to have medicinal qualities, e.g. to heal anemia, general malaise, fever, diabetes, typhoid, and asthma.

The vegetables identified were reported to be available throughout the year, purchased by market vendors from farmers in nearby villages and towns within travel distances of 10 to 100km. For the Agbobloshie, Kaneshie and Malata markets, supply sometimes came from the Accra Central Market, imported from Togo. With the exception of waterleaf, which was reportedly collected growing wild in wasteland and yards, all the vegetables were cultivated. Overall, prices were modest when compared to exotic vegetables. Marketing and distribution of African leafy vegetables in the country is largely through vendors; not by supermarkets.

The significant variation in proximate, mineral and vitamin composition among indigenous leafy and fruit vegetables suggest that they could be used to complement each other in a diet (Nyadanu and Lowor 2015). For example, cocoyam leaves and fruits of Ethiopian eggplant (*Solanum aethiopicum*), which are significantly higher in protein, could be used to complement Amaranthus species, Jew's mallow and Turkey berry (*Solanum torvum*), which are significantly higher in iron, magnesium, phosphorus and zinc. Leaves of Jew's mallow and cocoyam are high in vitamin A content and could play a role in alleviating micronutrient deficiencies, such as vitamin A deficiency.

Other studies tell more about NUS consumption in Accra. Codjoet et al. (2016) found that mean dietary diversity for surveyed households was almost seven, with vegetables having the highest diversity, followed by cereal-based and grain products. Household characteristics that have statistically significant associations with dietary diversity included sex and level of education of household head, household wealth quintile, and sources of food. However, the authors observed that although there is high dietary diversity in the studied communities of Accra, there is low consumption of foods rich in micronutrients, such as fruits and milk/dairy products. In the urban context, women, poor households, and the non-educated are the most affected by this.

3.2 Challenges of NUS in Ghana

In a related study, Baak-Pou et al. (2020) analyzed why NUS are under threat in the Forest Savanna Transition zone of which the Upper Afram basin is part. Their study revealed that even though farmers continue to use a traditional mixed cropping system, the widespread use of agro-chemicals was limiting this practice, leading to more and more monocultures to the detriment of cultivation of a wide variety of indigenous crops. Authors expressed concern about this trend and suggest that local farmers should be advised and trained to refocus and maintain some of the traditional agricultural practices that ensured the cultivation of a wide variety of indigenous food crop varieties.

Other have pointed to other factors that affect the cultivation of NUS. The Ghanese government has in the last decade promoted the provision of subsidized mechanized ploughing services to farmers to modernize farming. According to Kansanga et al. (2019), this has led to what they call the *mechanization paradox* in which farm sizes are expanding, while cropping patterns are shifting away from traditional staple crops (pearl millet and sorghum) to market-oriented crops (maize, rice and groundnut). The authors are concerned that this change adversely affects the cultural dimension of food security, the organization of social life, and climate change adaptation. They recommend a policy change to address these challenges.

Gender informs agricultural practices, including the management of NUS, but very few studies address gender in agriculture in Ghana. Wringley-Asante et al. 2019 addressed gender dimensions of climate change adaptation strategies among smallholder crop farmers in the transition zone of Ghana. Their research results indicated that adaptation strategies are gendered with men mostly resorting to on-

farm agronomic practices, such as the use of artificial fertilizers and moving into new cash crops. Female farmers use similar on-farm agronomic practices, particularly artificial fertilizers to boost crop production, but most importantly resorted to petty trading in agricultural and consumable goods, an off-farm strategy. It was not clear if they traded in NUS.

Andani (2019) analyzed the determinants of the decisions by farm households in northern Ghana to produce indigenous food crops. Results show that NUS producer households are those that are relatively larger, with more young children and adult women than non-producer households. They manage larger farms that are dispersed in different locations, farther away from market centers compared to non-producer households. Econometric results indicate that women's utilization of crop income, farm size, awareness of the nutritional importance of indigenous crops, participation in food security projects, access to credit, and distance to markets, significantly influenced households decisions to produce indigenous food crops. The author suggests that the provision of credit, empowerment of women, targeting distant communities relative to markets and raising awareness, are key activities to promote indigenous food crops.

Results from Northern Ghana (Bellon et al. 2019) showed that households maintained high levels of crop diversity: up to eight crops grown, with an average of 3.2 per household, and with less than 5% having a null or very low level of crop diversity. The value of crop species used for self-consumption was on average 55% higher than that of crop sales. Regression results show that crop diversity is positively associated with self-consumption of food crops, and cash income from crops sold. This finding suggests that increasing crop diversity opens market opportunities for households, while still contributing to self-consumption (Photo 4). Given these findings, crop diversification seems to be more beneficial to these farmers than specialization. For these diversified farmers, or others in similar contexts, interventions that assess and build on their de facto crop diversity are probably more likely to be successful.

Photo 4

Exemplary diversified farm in the Upper Volta region. Credit: The Alliance of Bioversity International and CIAT/R. Vernooy

4. Policies and institutions for the promotion of NUS

In Ghana, the challenge of food insecurity remains a major concern, particularly in the three northern regions. The 2009 Comprehensive Food Security and Vulnerability Analysis (CFSVA) reported that food insecurity is most severe in regions with adverse weather conditions, such as floods and droughts; and these are the poorest regions of the country. Ghana has neglected underutilized crops and plant species on food security; for example, the 2013 Accra Statement for a food secure Africa argued that African countries should be pursuing agricultural and food policies based on a limited number of crops, such as maize and rice, but little has been done.

A report published in Ghana in 2007 (Aboagye et al. 2007) concluded that there was at that time not a single comprehensive policy document on NUS, although some of the official documents consulted mentioned them. Organizations surveyed responded to have strategies and activities on NUS, but they were not coordinated, due to the lack of a holistic policy on these species. Authors therefore recommended the formulation of a clear policy by the relevant sector ministries on the inventory, identification, research and conservation of NUS as the basis for the development and promotion of these species. They argued that the government should enact laws and formulate policies relating to education and training – both formal (schools, colleges and universities) and informal (farmers) - to create awareness about the value and importance of production and consumption of NUS as import substitution plants for food, agriculture, industry and medicine. Government, the private sector and development partners should provide the necessary financial support for research, development and promotion of NUS in Ghana.

Ghana currently still lacks a comprehensive policy on the use of underutilized crops, but at least one prominent NUS researcher and author recommended to develop one (Baa-Poku 2018). The same author observed that the (first) Food and Agriculture Sector Development Policy (FASDEP) (2002) emphasized only priority crops based on their economic value to the neglect of other important indigenous crops, i.e. export crops (coconut, cocoa, oil pam and rubber) based on the comparative and competitive advantage of particular agro-ecological zones and availability of (international) markets. Linking smallholder farmers to outgrowers and to industry was one of the strategies to be promoted. FASDEP did not particularly address the challenge of marginalization of NUS even though their potential to contribute to food security especially among rural households is known. FASDEP II (2007) [4] promoted only selected priority or major crops based on their economic importance to the neglect and marginalization of other indigenous crop varieties (Baa-Poku 2018, 2020).

The current government of Ghana has identified as one of its priorities to make agriculture more productive and resilient while also creating new employment opportunities, for youth in particular. According to Ghana's Ministry of Food and Agriculture, among the key agricultural development issues are the low level of public sector investment; low institutional capacity of the public sector at all the three levels of government to deliver the enabling environment for the growth of the sector; poor marketing systems; inadequate access to land and security of tenure for agriculture production; low transfer and

[4] http://www.fao.org/faolex/results/details/en/c/LEX-FAOC144957/

uptake of research findings; low application of science and technology especially among smallholder farmers; low quality of genetic material for crop, livestock and fish species; and, poor agronomic practices (MOFA Republic of Ghana 2018).

FASDEP 1 and 2 were complemented by another strategy: *Investing for Food and Jobs (IFJ): An Agenda for Transforming Ghana's Agriculture (2018-2021)*, linked to the Medium-Term National Development Policy Framework (MTNDPF) entitled *Agenda for Jobs: Creating Prosperity and Equal Opportunity for All (2018-2021)*. The transformed agricultural sector is expected to open up the potentials to increase incomes, create jobs and provide raw materials to industry with a strong focus on creating an enabling environment for private sector operators and other actors within the various commodity value chains (MOFA Republic of Ghana 2018). The flagship project under the IFJ is the Planting for Foods and Jobs project, which has five pillars: 1) supply of improved seeds to farmers at subsidised prices (50% subsidy); 2) supply of fertiliser at subsidised prices (50% price cut out); 3) free extension services to farmers; 4) marketing opportunities for produce after harvest; and, 5) E-Agriculture (a technological platform to monitor and track activities and progress of farmers through a database system). The five main crops selected are maize, rice, soybean, sorghum and vegetables (tomato, onion, chili pepper) (the evolution of the project can be tracked on GhanaWeb).

The country receives technical and financial support from various organizations to bring about this transformation in agriculture. For example, the Food and Agriculture Organization of the United Nations (FAO) is assisting the government to strengthen its capacity to deal with the ecological, social and economic risks associated with agricultural sector production, in particular, pests, diseases and climate change. FAO also supports improving the preparedness and response to emergencies, natural disasters and crises in the agricultural sector (FAO 2019).

One study investigated the pathways to promote agricultural production and dietary diversity for a local market intervention called Home-Grown School Feeding (HGSF). School feeding menus from 24 districts across 10 regions in Ghana during the 2014-15 school year were analysed in terms of food groups and several individual foods. The menus were then compared with food groups produced by households during the past year or consumed in the past seven days using data collected from a household survey. Greater inter-food group diversity in the menus was associated with higher production levels for tubers and dark, leafy green vegetables in the South and cereals in the North. A correspondence between the frequency in which a food group appeared in a menu and the share of households who consumed foods from the food group was noted. Key issues, such as optimizing supply chains, enabling farm linkages and supporting diverse nutrient rich food groups, that underlie the success of Home-Grown School Feeding and other agricultural policies with similar goals of promoting production and dietary diversity are highlighted through commodity specific examples. The findings of this study may help strengthen operational linkages between agriculture production and nutrition for HGSF and other similar interventions.

This very brief review of Ghana's key agricultural policies and projects points to a very strong focus on major staple crops and commodities, with very limited attention paid to neglected and underutilized crop species (NUS). The *Investing for Food and Jobs* strategy has a short section on dietary diversity, which mentions the importance of locally available foods. The strategy states, "the government will educate and train consumers on appropriate food combinations of available foods to improve nutrition, and develop and enforce policies for serving locally available foods (fresh foods, vegetables) at workplaces and public functions." (MOFA Republic of Ghana 2018: 50) The document does not give details about how this will be done.

4.1 Key institutions

Animal Research Institute (ARI)
The ARI maintains a museum of both local and exotic forage plants, for example: *Cajanus cajan, Leucaena leucocephala, Brachiaria brizantha, Centrosema pubescens* and *Stylozanthes guinensis*.

Agricultural Research Station (ARS)
The ARS conserves and distributes a wide range of plantation crops, which include avocado, banana, cocoa, coffee, kola species, plantain, and rubber.

Cocoa Research Institute of Ghana (CRIG)
The institute works on its mandate tree crops, which include cashew, cocoa, coffee, kola, and shea.

Crops Research Institute
This Institute is mandated to carry out research on all crops except cashew, cocoa, coconut, coffee, kola, oil palm and shea butter. It has a museum of mango, citrus and oil palm. It has a tissue culture laboratory for the multiplication of banana, pineapple, plantain, sweet potato and yam. It also maintains a working collection of Bambara groundnut, cassava, cowpea, groundnut, rice, and soybean.

Oil palm Research Institute (OPRI)
The OPRI maintains a group of elite coconut and palm trees, which are used as germplasm improvement in the oil palm and coconut.

The Plant Genetic Resources Research Institute (PGRRI) in mandated to collect and conserve the plant genetic resources of Ghana, to prevent them from extinction. It holds accessions of cereals, legumes, forest species, fruit trees. medicinal plants, vegetables and spices. The materials collected and conserved are available to the scientific community, farmers and non-governmental organization for their exploitation, to provide good planting materials to meet the needs of users for increased agricultural production. At present, the PGRRI conserves seven cereals, 21 fruit species, 12 legumes, nine roots and tubers, and 23 vegetable species (personal communication, PGRRI curator, August 2021; see the annex for the complete list).

Photo 5

Some NUS in the Adowso market. Credit: The Alliance of Bioversity International and CIAT/R. Vernooy

Savannah Agricultural Research Institute (SARI)
SARI is mandated to carry out agricultural research, particularly as it relates to food and fibre crops in northern Ghana, in order to improve agricultural productivity and promote food security in the northern sector of the country. SARI maintains a working collection of Bambara groundnut, cowpea, groundnut, millet, pigeon pea, rice, sorghum, and soybean. It has collections of cassava, Chinese potato (*Solenostemon rotundifolium*), cotton and yam.

5. Some key insights from the review

- Ghana has a high number of documented NUS (72), which is about 60% of the number [126] for all of Africa. These include 21 indigenous vegetables, 8 root and tuber crops, 7 cereals, 12 legumes and 24 edible wild fruit trees. One study (2015) identified 20 very popular species (most marketed and consumed) among the 76.
- However, studies observe that NUS cultivation is under pressure due to socio-economic changes, modernization of agriculture (mono-cropping, mechanization and use of chemical inputs), agrarian conflicts (e.g. livestock infringement on cropland) changing eating habits and policies that are not favoring NUS production and consumption.
- NUS are reported to suffer from genetic erosion (in particular, loss of varieties). There has hardly been any crop improvement (plant breeding) done on NUS in the country.
- NUS are distributed throughout the country, but their location-specific presence is related to agro-ecological, climatic, socio-economic (e.g. distance to markets), and socio-cultural characteristics (e.g. ethnic identity).
- NUS and leafy vegetables in particular, are still important parts of eating habits, as studies in rural areas and in Accra show, with most of the supplies coming from rural Ghana, complemented with import from Togo. Fresh markets are the major sites for sales; there are very few NUS available in supermarkets. It is not known what the impact of COVID-19 has had on production and market supply and, as a result, on consumption.
- There is the lack of knowledge about effective conservation and storage practices. This hinders the design of effective on-farm conservation strategies, for example, by community seed banks or similar organizations at community level.
- Only very few detailed crop species studies could be found in the literature; this makes observations about current production and consumption (and trends) very difficult.
- There is no national research program on NUS. This could be overcome by establishing effective research partnerships that undertake NUS research (including nutritional composition analysis, agronomic management and conservation studies, value chain studies, policy development) work to strengthen a key part of the knowledge base. The research results could be channeled to a multi-sectoral platform to better mainstream NUS into relevant national nutrition and food security policies, strategies and actions (Hunter et al. 2020).

- There is no supportive policy environment for NUS, which largely have been neglected by government, extension and research. To design NUS focused policies, work needs to be done on several, interrelated issues. They include: 1) understanding the incentives that guide the production activities that different groups of farmers adopt; 2) understanding of consumers' preferences and behavior regarding NUS; 3) design of policies and interventions that make sure that the high 'hidden' environmental costs of 'business-as-usual' food production are properly accounted for; 4) exploring if revenues from taxes on unhealthy food consumption could be used to subsidize healthy orphan crop consumption; 5) design of policies and interventions that improve access to finance for small and medium-sized enterprises to deliver nutritious foods (McMullin et al. 2021); 6) include NUS in curricula in schools in Ghana and Africa at large.

Photo 6

Tiger nut on sale along the Accra-Kumasi highway. Credit: The Alliance of Bioversity International and CIAT/R. Vernooy

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Annex

NUS in the national genebank of Ghana at the PGRRI (August 2021)

Vegetables

1. Amaranthus cruentus
2. Amaranthus hybridus
3. Basella alba
4. Celosia argentea
5. Corchorus olitorius
6. Cleome gynandra
7. Cucumeropsis edulis
8. Curcurbita maxima
9. Justicia tenella
10. Langenaria siceraria
11. Sechium edule
12. Sesamum radiatum
13. Solanum aethiopicum
14. Solanum macrocarpon
15. Solanum nigrum
16. Solanum torvum
17. Talinum triangulare
18. Telfaria occidentalis
19. Trichosanthes cucumerina
20. Vernonia amygdalina
21. Vitex doniana
22. Moringa oleifera
23. Roselle

Legumes

1. Cowpea (Vigna unguiculata)
2. Bambara groundnut (Vigna subterranean)
3. Cajanus cajan
4. Canavalia ensiformis
5. Canavalia gladiate
6. Cassia occidentalis
7. Centrocema pubescens
8. Crotalaria L spp
9. Macrotyloma geocarpum
10. Mucuna pruriens
11. Phaseolus lunatus
12. Pueraria phaseloides

Cereals

1. Digitaria exilis
2. Eleusine coracana
3. Eragrotis tef
4. Oryza glaberrima
5. Pennisetum glaucum
6. Setaria italica
7. Sorghum bicolor

Root and tuber Crops

1. Colocasia esculenta
2. Dioscorea bulbifera
3. Dioscorea cayenensis
4. Dioscorea dumetorum
5. Dioscorea praehensilis
6. Ipomea batatas (17 improved and 12 local varieties)
7. Solenostemon rotundifolius

8. Xanthosoma sagittifolium
9. Tiger nut (Cerperus esculentum)

Fruits

1. Adansonia digitata
2. Artocarpus altilis
3. Borassus aethiopicum
4. Crysophyllum albidum
5. Cola nitida
6. Cola millenii
7. Garcinia colae
8. Dacryodes klaineana
9. Dialium guineense
10. Diospyros vignei
11. Diospyros soubreana
12. Drypetes chevalieri
13. Irvingea gabonensis
14. Heisteria parvifolia
15. Morinda morindiode
16. Parkia biglobosa
17. Salacia cornifolia
18. Sclerocarya birrea
19. Synsepalum dulcificum
20. Uvaria chamae
21. Ximenia americana

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